Limited Efficacy of Empiric Antibiotics for Pediatric Facial Fractures

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Background: Controversies exist regarding the role of perioperative antibiotic use in pediatric craniomaxillofacial fracture repair.

Purpose: This study aims to identify factors associated with antibiotic prescribing patterns and measures the association between antibiotic exposure and postoperative infections.

Study Design, Setting, sample: In this retrospective cohort study, TriNetX, a research database, was used to gather data on patients under 18 years of age who underwent repair of facial fractures. The records were obtained from 2003 to 2021. Current Procedural Terminology codes for facial fracture procedures were used to identify patients.

Predictor/exposure/independent variable: Antibiotic use, defined as a binary categorical variable of whether or not patients received perioperative antibiotics. The secondary predictor variable was timing of antibiotic administration, categorized by pre, intra, and postoperative administration.

Main outcome variables: Postoperative infection, determined by International Classification of Diseases, 9th and 10th Revision codes within patient charts.

Covariates: Covariates included demographic variables such as age, sex, race, ethnicity, geographic location, and fracture characteristics, such as number of fractures and location of fracture.

Analyses: χ^2 analyses were used for categorical variables and two sample t tests for quantitative variables. Multivariable logistic regression was used to evaluate patient infection and antibiotic use with adjustment for covariates. P-values were 2-tailed and statistical significance was defined as $P < .05$.

Results: This cohort included 5,413 patients of which 70.4% were male, 74.4% identified as white, and 83.3% identified as non-Hispanic or Latino. There were no differences in postoperative infections in patients who received antibiotics compared to those who did not (0.9 vs 0.5%, respectively, $P = .12$). Nevertheless, antibiotic prescriptions have increased over the years. After controlling for relevant covariates, antibiotic use did not decrease the odds of infection (adjusted odds ratio 1.1, 95% CI 0.53 to 2.34, $P = .79$). There was a significant association between the timing of antibiotic use and infection

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(P = .044), with increased odds of infection when antibiotics were given postoperatively (adjusted odds ratio 3.8, 95% CI 1.2 to 12.07, P = .023).

Conclusion and Relevance: While antibiotic prescriptions have increased over the years, this study demonstrates there is no difference in postoperative infection rates for pediatric patients prescribed antibiotics and those where were not.

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Facial trauma results in more than 3 million facial injuries per year in the United States.[1] Facial fractures can be managed in a variety of ways, depending on their location, including closed or open reduction[2,3]; however, more extensive reconstructive surgery may be required in severe cases.

Perioperative management of facial fractures including timing, type, and the need for antibiotic use remains a controversial topic, likely because of the complexity and the variable presentation of these injuries.[4] In 2020, the Surgical Infection Society Therapeutics and Guidelines Committee released the guidelines for antibiotic administration in the management of traumatic facial fractures, in which they recommended avoiding antibiotic usage in both operative and nonoperative upper face, midface, and mandibular fractures.[5]

In a study comparing nonoperative facial fracture management in patients treated with and without antibiotics, neither group had any soft tissue infections after treatment.[6] Nevertheless, in a survey of otolaryngologists, plastic surgeons, and oral and maxillofacial surgeons, it was found that 66% prescribed prophylactic antibiotics for nonoperative fractures.[7] Studies investigating the management of antibiotics for operative facial fractures are equally as contradictory. For example, it has been demonstrated that antibiotics do not decrease infection rates in midface, frontal sinus, and mandibular fractures.[8,9] However, surveys show 85.2% of physicians will always prescribe antibiotics for patients with facial fractures.[7]

Appropriate understanding on when to prescribe perioperative antibiotics for facial fracture repairs is a vital skill in a surgeon's toolbox. With so many contradictory recommendations regarding the role of perioperative antibiotics in craniomaxillofacial fracture repair, it is difficult for physicians to determine the best course of action for individual patients. Very few studies assess the use of antibiotic medications in the pediatric population specifically.

The purpose of this study was to identify factors associated with antibiotic prescribing patterns and measure the association between antibiotic exposure and postoperative infections. The investigators hypothesize that antibiotics are likely overused in this patient population and do not influence postoperative infections. The specific aims of the study were: 1) compare infection rates among patients prescribed antibiotics and those who were not, and 2) determine risk factors for antibiotics prescriptions in this patient population.

Materials and Methods

STUDY DESIGN/SAMPLE

To address the research purpose, the investigators designed and implemented a retrospective cohort study. The study population was composed of all patients presenting for evaluation and management of facial fractures between 2003 and 2021. To be included in the study sample, patients had to be ≤18 years of age and underwent facial fracture surgery. Patients were excluded as study subjects if they were older than 18 years old at the time of fracture or did not have a Current Procedural Terminology (CPT) code for facial fractures.

VARIABLES

In this study, the predictor variable is antibiotic usage. The study investigated predictors of antibiotic use as well as infection rates based on antibiotic usage. Covariates included demographic variables such as age, sex, ethnicity, geographic location, as well as fracture characteristics, such as number of fractures, and location of fracture. Using the TriNetX Research Network database, data were requested for all patients with facial fracture CPT codes. Individual deidentified patient data were imported and analyzed in Python 3 (Python Software Foundation, Beaverton, Oregon). Procedure, diagnosis, and medication codes for all patients were extracted and manually evaluated for variables of interest. Therefore, facial fracture and postoperative infections were all-inclusive for the cohort. The primary independent variable was a binary assessment of whether or not a patient received perioperative antibiotics. A secondary predictor variable of timing of antibiotic administration was evaluated. Preoperative antibiotics were defined as given 1 month before surgery, intraoperative antibiotics were given the same day as surgery, and postoperative antibiotics were given up to 1 month after surgery. Patients could be included in multiple categories. All codes used to identify patients can be found in Appendices A-D. The main outcome variable was postoperative infections. Postoperative infections were determined by International Classification of Diseases, 10th Revision codes in patient charts. Patients were determined to have a postoperative infection if they had a code listed in Appendix C 60 days after surgical procedure for facial fractures.

Covariates included demographic variables such as age, sex, race, ethnicity, geographic location, as well as fracture characteristics, such as number of fractures, and location of fracture. Age was a categorical variable including two age groups, ages 0 to 12 and 12 to 18 years old. Sex included male and female categories. Race was defined as a categorical variable including White, African American, Asian, and Native American or Pacific Islander. Ethnicity contained two categories: Hispanic or Non-Hispanic. Geographical location was also a categorical variable that included the Midwest, Northeast, South, and Western parts of the United States. The number of facial fractures was divided into five categories: one, two, three, four, and greater than or equal to five facial fractures. Similar categories were used for fractures located elsewhere on the body, determined by codes listed in Appendix D. Location of facial fracture was determined and defined by procedural codes in the patient charts (Appendix A).

DATA COLLECTION METHODS

This analysis utilized the TriNetX Research Network to identify patients less than or equal to 18 years of age who underwent facial fracture surgery. At the time of data gathering, TriNetX Research Network provided real-world clinical data of over 70 million patients that is aggregated and harmonized systemically from 57 healthcare organizations. TriNetX Research Network derives data from electronic health records and provides users with uniformly processed clinical data including demographics, diagnoses, lab results, medications, and procedures. Additional details about the TriNetX database can be found in the previous literature.[10,11] This study was determined to be exempt by the Penn State University Institutional Review Board (STUDY00018629).

DATA ANALYSIS

Patient characteristics and treatment-related measures were summarized using descriptive statistics. Groups were compared with χ^2 tests for categorical variables and two sample t tests for continuous variables. The number of fractures was determined by number of the CPT codes that were included in a patient encounter. The location of the fracture was determined based on the CPT codes associated with the procedure (Appendix A). Factors that were significantly different between those who did and did not receive antibiotics, as well as factors associated with postoperative infection, were considered in a multivariable regression model to evaluate whether antibiotic use was a significant predictor of postoperative infection, with adjustment for important covariates. Due to the low frequency of postoperative infection, only a small number of covariates could be included in the multivariable model. Factors chosen for the model included antibiotic use, age group, number of facial fracture procedures, and year. Results were reported in terms of adjusted odds ratios and 95% confidence intervals. *P*-values were 2-tailed and statistical significance was defined as $P < .05$. The same analyses were performed to evaluate the timing of antibiotic administration as a predictor of postoperative infection. All statistical analyses were completed using SAS statistical software version 9.4 (SAS Institute Inc, Cary NC).

Results

There were 5,413 patients included in the study, with 69.2% being over 12 years of age. The majority of the cohort were male (70.4%), white (74.4%), non-Hispanic or Latino (83.3%), and from the southern United States (54.2%). Over 70% of patients suffered from only 1 facial fracture.

Table 1 demonstrates the distribution of antibiotic use by patient demographics. There was a statistically significant association between antibiotic use in different age groups, with fewer patients under 12 years of age receiving antibiotics (25.5 vs 32.1%, $P < .001$). There was also an observed difference in ethnicity, with a greater proportion of non-Hispanic or Latino patients receiving antibiotics (64.9 vs 26.4%, $P < .001$). The Northeastern United States demonstrated the highest proportion of patients receiving antibiotics (64.1 vs 7.0% (Midwest), 29.8% (South), and 58.0% (West)). χ^2 comparison demonstrated there was a statistically significant association between region and antibiotic prescriptions ($P < .001$). As the number of facial fracture sites increased, patients were prescribed antibiotics more frequently (Table 1). Patients with LeFort fractures had the highest rate of antibiotic use compared to other fracture sites (37.9 vs 29.6%, $P = .002$), whereas patients with mandibular fractures had the lowest rate of antibiotic use compared to other fracture sites (27.5 vs 32.7%, $P < .001$). Overall, there has been an increase in the proportion of antibiotics prescribed for pediatric facial fractures from 2003 to 2021 (Fig 1).

Table 2 shows postoperative infection development by demographic variable. Of the entire cohort, there were 33 patients who developed a postoperative infection. There were no observed statistically significant differences between age, sex, race, ethnicity, and

Table 1. DISTRIBUTION OF ANTIBIOTICS USAGE BY PATIENT DEMOGRAPHICS

	Total n	No Antibiotics n (%)	Yes Antibiotics n (%)	χ^2 *P* Value
Age				<.001
0 to 12 years	663	1239 (74.5%)	424 (25.5%)	
13 to 18 years	3750	2546 (67.9%)	1204 (32.1%)	
Sex				.059
Female	1581	1071 (67.7%)	510 (32.3%)	
Male	3767	2650 (70.3%)	1117 (29.7%)	
Race				.0730
White	2910	1906 (65.5%)	1004 (34.5%)	
African American	894	566 (63.3%)	328 (36.7%)	
Asian	67	42 (62.7%)	25 (37.3%)	
Native American or Pacific Islander	40	33 (82.5%)	7 (17.5%)	
Ethnicity				<.001
Hispanic or Latino	647	476 (73.6%)	171 (26.4%)	
Not Hispanic or Latino	3221	2089 (64.9%)	1132 (35.1%)	
Regions				<.001
Midwest	1436	1335 (93.0%)	101 (7.0%)	
Northeast	758	272 (35.9%)	486 (64.1%)	
South	2930	2057 (70.2%)	873 (29.8%)	
West	281	118 (42.0%)	163 (58.0%)	
Number of facial fracture procedure				<.001
1 Fracture	3845	2800 (72.8%)	1045 (27.2%)	
2 Fractures	1130	723 (64.0%)	407 (36.0%)	
3 Fractures	225	137 (60.9%)	88 (39.1%)	
4 Fractures	126	74 (58.7%)	52 (41.3%)	
≥5 Fractures	87	51 (58.6%)	36 (41.4%)	
Number of other fractures				<.001
No Fracture	5061	3592 (71.0%)	1469 (29.0%)	
1 Fracture	138	84 (60.9%)	54 (39.1%)	
2 Fractures	58	36 (62.1%)	22 (37.9%)	
3 Fractures	34	15 (44.1%)	19 (55.9%)	
4 Fractures	19	10 (52.6%)	9 (47.4%)	
Location				
Mandible	2765	2004 (72.5%)	761 (27.5%)	<.001
Orbital	1365	946 (69.3%)	419 (30.7%)	.56
Maxillary	137	104 (75.9%)	33 (24.1%)	.12
Nasal	299	195 (65.2%)	104 (34.8%)	.07
Zygomatic	81	51 (63.0%)	30 (37.0%)	.17
LeFort	314	195 (62.1%)	119 (37.9%)	.002
Other	645	382 (59.2%)	263 (40.8%)	<.001

This table demonstrates the number and percentage of patients in each demographic category that received antibiotics or did not receive antibiotics. The χ^2 analysis is determining difference between groups for each demographic variable.

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geographic location when assessing the development of infections. There was a statistically significant higher rate of postoperative infections in patients with nasal fractures (*P* = .02) and LeFort fractures (*P* = .02). Additionally, there was a statistically significant association between the number of facial bones that were fractured and the development of a postoperative infection, with a larger percentage of postoperative infections (*P* = .048) in patients with a greater number of facial bones that were fractured (Table 2). However, there was no association between postoperative infections in patients whether perioperative antibiotics were used or not (*P* = .12). This information can be observed in Table 3.

The significant demographic and clinical variables were evaluated for inclusion as covariates in a

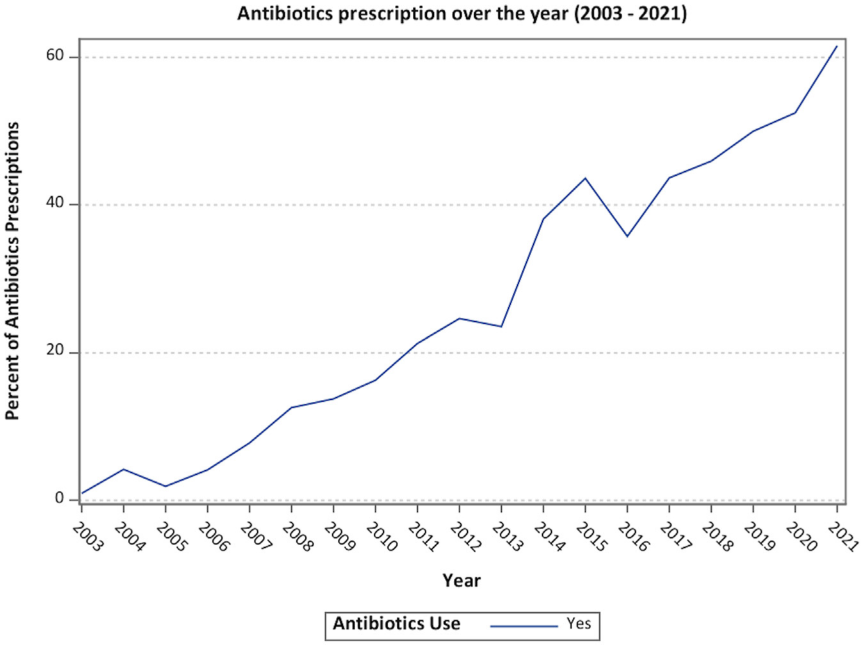

FIGURE 1. Percent of antibiotic prescriptions throughout the years for the cohort of pediatric facial fractures (N = 5413).

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multivariable logistic regression model to predict postoperative infection. Due to the low frequency of postoperative infection, only a small number of covariates could be included in the multivariable model. Factors chosen for the model included antibiotic use, age group, number of facial fracture procedures, and year. With adjustment for these factors, the odds of postoperative infection were not statistically significantly decreased with antibiotic use (adjusted odds ratio 1.1, 95% CI 0.52 to 2.34, *P* = .79). The odds of postoperative infection were 1.5 times greater for each additional facial fracture (95% CI 1.5 to 1.01, *P* = .043). This information is demonstrated in Table 4.

Additional analyses of the secondary predictor variable of timing of antibiotic administration were conducted. Of note, there was a statistically significant association between the timing of antibiotic administration and the development of a postoperative infection (*P* = .025), with the majority of patients who developed postoperative infections receiving antibiotics intraoperatively, as opposed to pre or postoperatively. Table 5 demonstrates the development of postoperative infection based on timing of administration. Of note, there was a significant difference in timing of antibiotic administration for all locations except for zygomatic fractures. Mandible, orbital, maxillary, and other locations had a higher percentage of intraoperative antibiotic use compared to pre and postoperative use. Nasal and LeFort fractures most often had antibiotics administered preoperatively.

The same demographic and clinical variables were included as covariates in a multivariable logistic regression model to evaluate timing of antibiotic use as a predictor of postoperative infection. With adjustment for age group, number of facial fracture procedures, and year, there was a significant association between the timing of antibiotic use and postoperative infection (*P* = .044), with increased odds of infection when antibiotics were given postoperatively (adjusted odds ratio 3.8, 95% CI 1.2 to 12.07, *P* = .023). This information is demonstrated in Table 6.

Discussion

The purpose of this study was to identify factors associated with antibiotic prescribing patterns and measure the association between antibiotic exposure and postoperative infections. We hypothesized that antibiotics are likely overused in this patient population and may not influence patient infections. The utility of antibiotics likely depends on patient presentation and fracture characteristics. Specifically, this study aimed to 1) compare infection rates among patients prescribed antibiotics and those who were not, and 2) determine risk factors for antibiotics prescriptions in this patient population. To our knowledge, this study is the first large database analysis investigating the prescribing patterns and the use of antibiotics in the pediatric population. Antibiotic prescribing depends on patient characteristics, geographic location, and fracture presentation. There were no differences in postoperative infections between patients prescribed antibiotics and those who did not utilize antibiotics.

Table 2. DISTRIBUTION OF POSTOPERATIVE INFECTIONS BY DEMOGRAPHIC VARIABLE

	Total n	No infection n (%)	Yes infection n (%)	χ^2 *P* Value
Age				.15
0 to 12 years	1663	1649 (99.2%)	14 (0.8%)	
13 to 18 years	3741	3722 (99.5%)	19 (0.5%)	
Sex				.21
Female	1581	1568 (99.2%)	13 (0.8%)	
Male	3767	20 (0.5%)	20 (0.5%)	
Race				.73
White	2910	2887 (99.2%)	23 (0.8%)	
African American	894	889 (99.4%)	5 (0.6%)	
Asian	67	67 (100.0%)	0 (0.0%)	
Native American or Pacific Islander	40	40 (100.0%)	0 (0.0%)	
Ethnicity	642			.80
Hispanic or Latino	647		5 (0.8%)	
Not Hispanic or Latino	3221	3199 (99.3%)	22 (0.7%)	
Regions				.64
Midwest	1436	1429 (99.5%)	7 (0.5%)	
Northeast	758	751 (99.1%)	7 (0.9%)	
South	2930	2913 (99.4%)	17 (0.6%)	
West	281	279 (99.3%)	2 (0.7%)	
Number of facial fracture procedure				.048
1 Fracture	3845	3823 (99.4%)	22 (0.6%)	
2 Fractures	1130	1125 (99.6%)	5 (0.4%)	
3 Fractures	225	222 (98.7%)	3 (1.3%)	
4 Fractures	126	123 (97.6%)	3 (2.4%)	
≥5 Fractures	87	87 (100.0%)	0 (0.0%)	

Note: This table demonstrates the number and percentage of patients in each demographic category that developed a postoperative infection or did not develop a postoperative infection. The χ^2 analysis is determining difference between groups for each demographic variable.

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Antibiotic stewardship is an effort to improve how antibiotics are prescribed by clinicians and used by patients, with the goal of preventing the development of antibiotic resistance. The use of antibiotics for facial fracture repair is poorly understood. Antibiotic use may depend on the location or number of fractures, as well as provider preference. There are not well-established guidelines for antibiotic use in pediatric patients with facial fractures. The management of facial fractures in pediatric patients differs from adults due to different stages of skeletal development.[12] This patient population is of specific interest; as early introduction of antibiotics may lead to increased antibiotic resistance.

Similar to previous studies investigating patients with facial fractures, this study demonstrates that patients with facial fractures tend to be over the age of 12, and are more likely white, and male.[8,12]

Table 3. BIVARIATE ANALYSIS OF ANTIBIOTIC USAGE VS POSTOPERATIVE INFECTION

	Total n	No infection n (%)	Yes infection n (%)	OR (95%CI)	χ^2 *P* Value
Antibiotics Use				1.7 (0.86-3.44)	.12
No	3785	3766 (99.5%)	19 (0.5%)		
Yes	1628	1614 (99.1%)	14 (0.9%)		

Note: This table demonstrates that antibiotic usage is not significantly associated with infection development.

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Table 4. ADJUSTED ODDS RATIOS AND 95% CIS FROM THE MULTIVARIABLE ANALYSIS TO EVALUATE ANTIBIOTIC USE AS A PREDICTOR OF INFECTION WITH ADJUSTMENT FOR RELEVANT COVARIATES

	Adjusted Odds Ratio	95% Confidence Limits		*P*-value
		Lower Limit	Upper Limit	
Antibiotics Use				.79
Yes vs No	1.1	0.52	2.34	
Age				.11
0 to 12 vs 13 to 18	1.8	0.87	3.55	
Fracture description				
Year	1.1	1.02	1.17	.018
Number of facial procedures	1.5	1.01	2.17	.043

Note: This table demonstrates the adjusted odds ratios for the categorical covariates versus the corresponding reference category, and adjusted odds ratios for every 1-unit increase in the continuous covariates.

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Interestingly, the Northeast region demonstrated the highest proportion of patients receiving antibiotics. This aligns with results from a previous study assessing antibiotic use across the country for upper respiratory infections.[13] Antibiotic prescription for pediatric facial fracture management has increased over the years, with no clear evidence to support the use of antibiotics in this population.

Some previous studies demonstrate utility of antibiotics in adult facial fractures. In a cohort of patients with facial fractures surgeries, 42.2% of patients who did not receive antibiotics developed postoperative infections, compared to only 8.9% of patients who received antibiotics.[14] Additionally, a randomized clinical trial determined cefazolin prescribed perioperatively diminished postoperative infections, with the majority of patients enrolled in this study suffering mandibular or Le Fort fractures.[15] However, other studies have demonstrated little evidence to support the use of antibiotics in facial fracture management.[16,17]

Interestingly, the Surgical Infection Society recommended avoiding preoperative and postoperative antibiotic prescriptions for nonmandibular fractures.[5] Yet, 85% of surveyed physicians still prescribe preoperative, intraoperative, or postoperative prophylactic antibiotics for surgically managed facial fractures, demonstrating a lack of consensus between recommendations and current practices of physicians.[7] Further, Mundinger et al investigated evidence-based literature recommendations as they aligned with physician practice and found incongruities, with physicians often overprescribing. Of note, studies contained low levels of evidence and could not undergo quantitative analysis.[18]

In our study, the severity of the facial fractures and the location of fracture influenced the utilization of antibiotics. Patients who had a greater number of facial fractures were prescribed antibiotics more frequently. Lauder et al also discusses how patients with a higher severity of trauma may receive an additional antibiotic regimen.[8] There have been a great number of studies in the literature on antibiotic use in adult mandibular fractures.[9,19,20] Although, the literature does not support the use of antibiotics in mandibular factures, several studies have demonstrated that antibiotics continue to be commonly prescribed.[19,20] However,

Table 5. BIVARIATE ANALYSIS OF TIMING OF ANTIBIOTIC USAGE VS POSTOPERATIVE INFECTION

	Total n	No infection n (%)	Yes infection n (%)	OR (95% CI)	Fishers Exact *P* Value
Timing of administration					.008
None	3194	3180 (99.6%)	14 (0.4%)	Ref	
Preoperative	660	658 (99.7%)	2 (0.3%)	0.7 (0.16-3.05)	
Intraoperative	1396	1383 (99.1%)	13 (0.9%)	2.1 (1.00-4.55)	
Postoperative	163	159 (97.6%)	4 (2.5%)	5.7 (1.86-17.56)	

Note: This table demonstrates that the timing of antibiotic usage is significantly associated with infection development.

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Table 6. ADJUSTED ODDS RATIOS AND 95% CIS FROM THE MULTIVARIABLE ANALYSIS TO EVALUATE TIMING OF ANTIBIOTIC USE AS A PREDICTOR OF INFECTION WITH ADJUSTMENT FOR RELEVANT COVARIATES

	Adjusted Odds Ratio	95% Confidence Limits		Overall *P* Value
		Lower Limit	Upper Limit	
Timing of Administration				.044
Preoperative vs None	0.4	0.09	1.86	
Intraoperative vs None	1.4	0.62	3.20	
Postoperative vs None	3.8	1.20	12.07	
Age				.13
0 to 12 vs 13 to 18	1.7	0.85	3.45	
Fracture description				
Year	1.1	1.01	1.17	.024
Number of facial procedures	1.5	1.05	2.26	.029

Note: This table demonstrates the adjusted odds ratios for the categorical covariates versus the corresponding reference category, and adjusted odds ratios for every 1-unit increase in the continuous covariates.

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the current study found that patients with mandibular fractures were less likely to be prescribed antibiotics compared to other facial fracture sites. While this is in contrast to previous studies, perhaps it demonstrates a more recent change in practice, and enforces evidence-based medicine.

Previous literature reports a range of 0 to 13% of patients developing surgical site infections after facial fracture management.[21-24] The current study demonstrated no difference in rates of infection whether antibiotics were used or not. This ultimately supports a decreased need of antibiotics in pediatric facial fracture management. In accordance with our findings, Lauder et al found no difference in infection rates for patients.

When assessing timing of administration, our study found that after controlling for relevant covariates, patients who received postoperative antibiotics had increased odds of developing infection compared to no antibiotics. A previous study also demonstrated there was an increased rate of infection with the use of antibiotics for skull base fractures.[25] Of note, in the current study there were no significant differences between those who were given preoperative or intraoperative antibiotics compared to no antibiotics. With having only 33 patients develop infections, it is difficult to make generalizable conclusions. Future studies are required to determine the ideal timing of antibiotic delivery for facial fracture procedures, if antibiotics are to be used.

While the current study provides insight to the utilization of antibiotics over the years in pediatric population, there are some limitations. Our study is limited by the retrospective nature of a database study as the results are dependent on clinician diagnosis and accurate documentation. Additionally, the antibiotic dosage information was extremely limited within the database, and therefore we could not comment on the dosage of the prescribed antibiotic regimen.

Antibiotic stewardship is an important tool to decrease unnecessary antibiotic use and therefore prevent antibiotic resistance. This study shows that antibiotic prescriptions have increased over the years, despite negligible impact on postoperative infection rates. The current study demonstrated no difference in postoperative infection between patients who were prescribed antibiotics and those who were not. Age, ethnicity, geographical location, and severity of fractures were associated with higher likelihood of antibiotic prescription. Additional research studies need to be conducted, and organizations should publish recommendations. However, physicians must also take it upon themselves to stay up to date with current literature and practice evidence-based medicine. The various presentations of facial fractures necessitate individualized management, adding additional challenge for physicians.

Supplementary Data

Supplementary data associated with this article can be found in the online version, at 10.1016/j.joms.2023.03.017.

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